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HOT MASSIVE BINARIES

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INTRODUCTION

This grant was awarded in correlation with one of similar intent and technique to the U.K. SERC. The intention was to permit the use by the American team (R. H. Koch, Y. Kondo, G. E. McCluskey, R. J. Pfeiffer, and J. Sahade) of an 8-hour shift (US2) with the *International Ultraviolet Explorer (IUE)* to be followed directly by an 8-hour shift by the U.K. team. Awards of two such shifts on each of three consecutive days would permit very ample coverage of the targets. The awards were, in fact, made for an early observational run but were then rescinded and the time given to another project which presumably had higher priority. A comparable amount of makeup spacecraft time was then awarded but very near the end of the award interval so that it would be impossible to complete the science in the year as originally expected. For this reason, a no-increase-in-funds extension was sought and granted.

THE SCIENTIFIC PROJECT

The intention of the collaborative project was to observe two hot, massive, nearly unevolved close binaries so as to determine their masses more accurately than had been done hitherto and more accurately than could be done from ground. The transatlantic teams agreed on the targets LZ Cep and Y Cyg, which were known to be very important for binary evolution and which could be exploited with minimal slewing of the spacecraft. No problems were encountered in obtaining the UV spectra. The apportionment of the reduction and analysis was easily agreed to between the teams with the recognition that the U.K. team had access to more

powerful software. A certain amount of mutual checking was accomplished.

THE RESULTS

The U.S. team completed the analysis of the photospheric and wind absorptions of the Y Cyg spectra quite promptly. These results were presented as a poster paper at the January, 1991 meeting of the AAS in Philadelphia and were published as 1991, *Bull. A.A.S.* **22**, 1292 by R. H. Koch, I. Pachoulakis, R. J. Pfeiffer, G. E. McCluskey, and Y. Kondo. The other Co-I on the original proposal, Sahade, was out of the country and could not contribute to this paper. Pachoulakis, the graduate student Research Fellow supported by the grant, mastered a considerable amount of software capability and line-formation theory working on the spectra. Subsequently, the U.S. and U.K. images were all reduced by our British colleagues with better software, and the velocity curves improved measurably as a consequence. This work is being prepared for publication. In addition, Pfeiffer, Pachoulakis, and Koch discovered in August, 1991 that continuum, photospheric absorption, and wind absorption light curves can all be recovered from the images. These light curves are not of a unique morphology in that the continuum and photospheric absorption ones resemble visible-band ones from ground while the wind absorption light curves are those of a seeming contact binary. This finding seems to imply that we have discovered the location where the C IV ions create a systemic envelope enlongated along the line connecting the stars. More work must be done on this result but it appears that it should correlate with the

ground-based polarization curves which derive from electron scattering. (This work had already been published several years ago by Pfeiffer and Koch.)

As the Y Cyg spectra were being analyzed at Pennsylvania and Trenton, the velocities of LZ Cep were being reduced and analyzed in the U.K. The velocity curves turn out to be vastly more precise and accurate than those from ground as had been expected. In addition, the spectrophotometry as well as the velocities permit outlining an model of this ellipsoidal variable which fits reasonably with conventional binary evolutionary theory. This set of results appeared as 1991, *Obs*. **111**, 167 by I. D. Howarth, D. J. Stickland, R. K. Prinja, R. H. Koch, and R. J. Pfeiffer. While the IUE spectra were being accumulated, Koch had observed a polarization curve of the binary from Pennsylvania. This has now been analyzed by Pfeiffer and Koch leading to a systemic scattering envelope apparently fed by the wind from each star, which winds collide in a shock between the stars. This model is also being prepared for publication. When it will have been done, we plan to look at the light curve information in the images to see if we can detect a wind-absorption envelope as we have for Y Cyg.

With both the UV spectra and ground-based polarimetry having been observed, another Co-I, E. F. Guinan, fostered the collection of ground-based light curves at the ATP facility in Mesa, AZ. Our target stars form just two of a large budget of stars which are observed automatically by the telescope each clear night and this meager dedication of telescope time has been insufficient to

accumulate well-covered light curves. Nonetheless, the effort has been useful in updating the ephemerides of the target binaries.